K2 Proposal on behalf of KASC WG 3 (field 2)

Asteroseismology of roAp and Ap Stars

Prepared by Victoria Antoci, Peter De Cat, Luis Balona , Gerald Handler

---

The chemical peculiarity in Ap stars is a result of the interplay between gravitational settling and radiative acceleration in the presence of a strong magnetic field which leads to the upwards diffusion of metals. A subset of the Ap stars, the rapidly-oscillating (roAp) stars, pulsate in multiple periods in the range 5-20min. The current idea is that pulsational instability is a result of the κ mechanism in the hydrogen ionization zone. Convection is stabilized around the magnetic poles owing to the kilogauss field strength, allowing pulsational driving to overcome the damping. Unfortunately, the predicted instability strip does not match the observed instability strip (Cuhna, 2002MNRAS, 333, 47C; Theado et al., 2009A&A, 493, 159). Furthermore, the pulsational periods in many roAp stars are shorter than the critical cut-off periods (Saio, 2013arXiv1309.7251S).

Observations of roAp stars from the Kepler space telescope has changed our perspective of roAp stars quite significantly. There are three well-studied roAp stars in the *Kepler* field. Perhaps the greatest surprise was the discovery of a low-frequency variation in KIC8677585 (Balona et al., 2011MNRAS.410, 517B) which appears to be linked to the high-frequency roAp pulsations (Balona et al., 2013MNRAS.432.2808B). In two other roAp stars a period of about twice the rotation period is present (Balona, 2013MNRAS.436.1415B). In another roAp star, there seems to be two different pulsation axes (Kurtz et al., 2011, MNRAS, 414, 2550). These discoveries are unexpected and unexplained and strongly suggest that our current understanding is inadequate.

There are two known Ap stars in the K2 FOV of campaign 2, which we propose to be observed in short-cadence mode. Both stars ω Oph (EPIC 204648355) and HD 150035 (EPIC 203092367) are bright targets, which allows us to do follow-up high-resolution time-series spectroscopy. These two targets would be the only roAp stars with high quality photometric data from *Kepler* and high-resolution time-series spectroscopy. This is a unique opportunity to determine the limits of the instability strip of roAp stars, eliminating the observational bias which probably exists in ground-based observations. It is important to know what fraction of Ap stars are δ Sct pulsators. The expectation has been that helium is partly drained from the driving region and that the fraction of Ap stars which are δ Sct stars should be small. We realize that SC slots are in high demand, so in the attached table, the two stars have been ordered according to perceived priority. We recommend that both stars be observed in short cadence mode, but failing this, it would be important that long-cadence observations be made of all Ap stars to investigate eventual δ Scuti oscillations and also to determine their rotational periods from the light variations.